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Water Resources Management and Sustainable Development of Tehsil Koil (District Aligarh) U.P., India-A Case Study

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Abstract: **This paper is concerned with a case study of the water resources and its management for the sustainable development of Tehsil Koil and its adjoining Blocks situated in district Aligarh of Uttar Pradesh, India. The status of existing water resources, lifestyle of people, water requirements for agriculture, industries, domestic use etc., have been investigated for which the field data of existing water resources, population, their occupation, their lifestyles, crops and cropping pattern, soil type etc., have been procured from Tehsil Koil, Block Development Offices, Government vatenary hospitals of Jawan, Dhanipur, Lodha and Aligarh city. The maps showing the existing water resources of Tehsil Koil and the blocks adjoining to it with adequate information have been collected from the Vikas Bhawan, District Aligarh. To examine the water quality of existing water resources of the area under study, water samples have been collected and standard tests have been performed in the laboratory of Civil Engineering Department, Z.H. College of Engineering and Technology, AMU, Aligarh. The amount of water available from existing water resources has been computed and compared with the amount of water needed for different requirements including irrigation, industrial, agricultural and domestic use. Present study reveals that except few villages of Dhanipur and Lodha blocks, water availability is satisfactory in existing water resources of Aligarh city and its adjoining blocks to meet the current requirements, however, at some places the water availability and water requirement are at their margin. At these places the water requirement may exceed the water availability due to rapidly changing life styles of the people. For such places sustainable strategies are proposed to cope with rapid growth in population, industries, agriculture and change in the lifestyle of people.**

1. INTRODUCTION

Water a precious natural resource, is vital for survival of life on the earth. Adequate water is needed for irrigation, power generation, navigations, industries, domestic requirements and wild life. Inadequate water resources lead to environmental threats. Crops, plants, forests vegetal cover and pasture are all dependent on water resource. In addition to this, assessment of water quality is very important for knowing the suitability for various purposes. A good irrigation system makes country self reliant in food requirements of the people. An ill managed water resource may lead to social problems. People to people, region to region and country to country conflicts over the water resource make the relations strained and creates political and social problems. Sustainable development of a country depends on better management of these two resources. The rapid growth of urban areas has further affected the groundwater quality due to over exploitation of resources and improper waste disposal practices have further made sustainable management of water resources a complex task to achieve throughout India (Scanlon et al, 2002).Therefore, sustainable planning and management of water resources has become a priority consideration for the economic and future welfare of the country. In view of the above it becomes importance to have prior information on quantity and quality of water resources available in the region, while planning developmental projects.

A number of studies concerned with water resource management has been carried out across the country *viz.* Santhana Bosu (1999), V.P. Gupta (2000), Pradhan et al (2001), Rani et al (2003), Salunkhe (2007), Shrivastava et al (2007), and have suggested various solutions and techniques for water conservation via direct rain water conservation, *in-situ* moisture conservation, water harvesting and using irrigation technology for harvested water and through agronomic and engineering measures. Water crisis is not a temporary phenomenon to be dealt with in a crisis management style. It requires long terms and lasting solution beyond the short term of decision makers in office, (Wim van der Hoeck, 2001).

2. AVAILABILITY OF SAFE WATER

Freshwater availability and consumption is of particular interest in India due to the country supporting an increasingly large population with decreasing per capita water supplies (Mall *et al.* 2006). Climate change offers the potential to significantly alter precipitation and surface water regimes in India (e.g., Chattopadhyay and Hulme 1997; Kumar *et al.*2005), while the anticipated population increase and expanding economy is expected to exacerbate stress on groundwater reserves (e.g., *Amarasinghe et al.* 2007; Jain *et al.* 2007). Safe water in sufficient quantities is fundamental to human health. The most important water-associated health problem is diarrhea, accounting for 3 to 5 million deaths per year, especially among children. Agricultural production consumes more fresh water than any other human activity (Falkenmark'89).

3. SUSTAINABLE DEVELOPMENT OF WATER RESOURCES

Without water, a harmonious and sustainable development of socioeconomic activities are not possible. For the purpose of improving the quality of life as a condition of achieving sustainable development, it is essential to secure sufficient water of good quality throughout the community without upsetting the natural equilibrium of the environment. Also if water is used without proper management strategies, sustainable development of the region will not be possible. Hence conservation, protection from pollution, proper management and development of existing sources of water is necessary. Sustainable development is possible only if concerned peoples are fully aware, educated and have their participation in these activities. This awareness will control loss of water through manmade leakages in the distribution system, wastages of water in the households.

4. IMPACT OF URBANIZATION ON WATER RESOURCES

Urbanization has especially increased in India to a substantial extent. It is to be assumed that the water problem in the megacities of the developing countries will continue to intensify. In this context, one of the key tasks of sustainable and long-term land and natural resources management is to optimize water resource utilization referring to the spatial distribution of people and their activities. The pressing *water quality* and quantity challenges posed by the depletion and degradation of water resources in urban India are confounded by climate change and variability (Jha et al. 2009). Water in the Indian subcontinent is highly susceptible to climate change.

5. MANAGEMENT OF WATER RESOURCES

The resources of water in the earth are limited but the use of water is increasing continuously because of increasing population. To meet the extending demand, existing resources have to be preserved and managed. The environmental and social problems associated with water scarcity point to a crisis in urban water resources management, and one that threatens the security and livelihood of the population and the environment over the coming decades (Mukherjee et al. 2005). Pure and safe water in sufficient quantities is primal to human health (Wim van der Hoeck, 2001 and Chatterjee et al 2006), considering this to be a fundamental objective along with the present scenario of population explosion across the country, a case study has been taken up to evaluate the water resource potential and quality of Tehsil Koil in Aligarh distt.and four of its blocks so as to propose efficient water management strategies for sustainable development in and around Tehsil Koil of Aligarh district..

6. DATA ACQUISITION

Field visits of Tehsil Koil (district Aligarh, U.P.) and four of its blocks; namely, Dhanipur, Jawan, Lodha and Aligarh city were made on regular basis to collect the data on existing water resource, total land areas, population and cattle density, average annual rainfall, irrigation as well as domestic water requirements and standards of living of the people.

For water quality assessment, water samples were collected from different blocks of Aligarh Koil as shown in figure 3(a to h).

(a) Water sample taken from Hand pump (India marka-2) of Lodha block

(b) Water sample taken from tube well of Lodha block

(c) Water sample taken from pond Dhanipur Block

(d) Water sample taken from pond No.3 – Avas Vikas colony (near Exhibition road), Aligarh city

(e) Water sample taken from pond Lodha block	**(f) Water sample taken from Jawan ca Jawan block Nal**
(g) Water sample taken from CPWD Tube well (OHT-Press colony) of Aligarh city	**(h) Water sample taken from pond No.1 –Aligarh city**

Figure 3. Collection of water samples for water quality assessment (a) Lodha block(b) Lodha block(c) Dhanipur Block(d) Aligarh city(e) Lodha block(f) Jawan block

To have an insight of the perspective water resource locations within the study area, a topographic map was acquired from the Vikas Bhawan and Tehsil Koil and also it is shown in Figs.1 and 2. Other details like population of town and its adjoining villages, irrigable land, non-irrigable land, barren land, soil type, amount of rainfall, revenue collection, total area of town and villages etc. were also acquired from the Vikas Bhawan and Tehsil Koil. Fig.1& Fig. 2,depict all the major water resources of the Aligarh Koil like canal, ponds, tube wells, wells, hand pumps, and municipal tanks.

The map indicates total of five ponds (each having an average capacity of 0.43 hectare-meters of water), canal having a discharge of 15 m^3/s, 15 wells, 30 tube-wells, 9512 hand pumps in the town. Apart from these water resources, map also reveals the city and blocks boundary, Kachcha and pakka houses, vacant plots, schools, telephone exchange, hospitals, railway station, mosques, temples etc. From these details, the standards of living of the people and their daily usage of water resources of Tehsil Koil could be assessed.

Figure 1. water resources details shown in Aligarh map

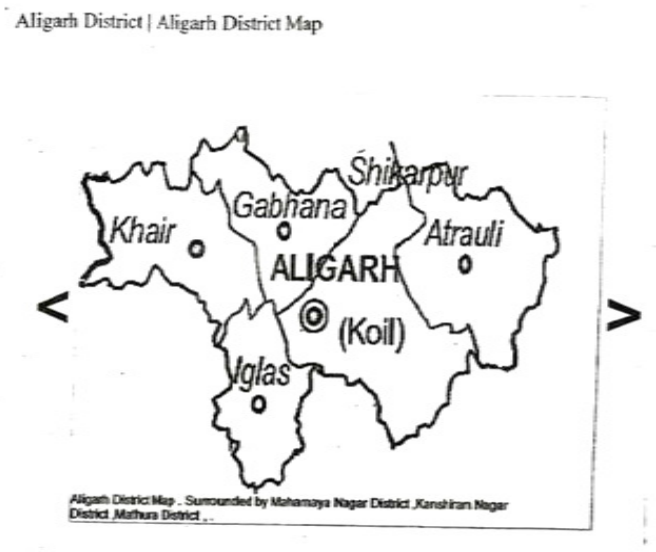

Figure 2. Map showing blocks in Aligarh Koil

To assess the water quality of water resources in the study area, water samples were collected tubewells, hand pumps, ponds, lakes and canals located within the study area. These samples were tested in the Environmental Engineering laboratory of Civil Engineering Department, A.M.U., Aligarh for alkalinity, total hardness, chloride, fluoride, arsenic, nitrate concentrations, pH and Total Dissolved Solids (TDS), and compared with the standards of drinking and irrigation proposed by Bureau of Indian Standards (BIS) so as to assess the quality of existing water resources.

7. QUANTITIES ASSESSMENT OF EXISTING WATER RESOURCES

The availability and quantity of existing water resources of Tehsil Koil and four of its adjoining blocks was assessed by utilizing the data collected through regular *in-situ* surveys. Details of the major existing water resources of Tehsil Koil and four of its adjoining blocks and their utilization for various purposes.

Table 1: Results of present study of Tehsil Koil

S. No.	Particulars	Quantity of water available from existing water resources in hectare meter	Quantity of water required for different uses in hectare meter
1.	Aligarh City	5138.5952	5491.316
2.	Jawan Block	24156.955	25770.575
3.	Lodha Block	18873.712	18743.773
4.	Dhanipur Block	23445.387	25490.711

The groundwater availability Tehsil Koil and four of its adjoining blocks was assessed by considering the groundwater availability per unit area of the entire Aligarh district multiplied by the individual areas of the study regions/villages. On the basis of Central Ground Water Board (CGWB), Ministry of Water Resources (India) statistics 2009, replenishable groundwater potential for Aligarh district was considered as 66010.66 Ha-m (*CGWB, 2009)*. The district extends to an area of 3747 sq-km. The groundwater potential of adjoining blocks is replenished form the net water groundwater available for Tehsil Koil (Table-1). Aligarh distt. Falling in the central ganga plain lies in interfluvial tract of ganga and Yamuna. The upper ganga canal,which flows roughly over the water divide from N-W direction to S-E direction divides the distt. Into two parts.Similarly, the averaged water availability of a total of five ponds in the town was reckoned on the basis of data collected from Vikas Bhawan and Tehsil Koil and was taken as 2.15 Ha-m. Data regarding crop area under different seasons served in quantifying the water requirements of different crops.

The domestic water requirements of the residents within the study area such as, drinking, washing and bathing have been assessed on the basis of per capita demand of the person per day. The water requirement of a single person per day (as per Indian Standard Specification, ISI standards) for Tehsil Koil is 135 liters per day . Likewise, the cattle water demand per day per cattle is considered as 15 liters per day (ISI standards).

8. WATER QUALITY ASSESSMENT

The quality of water in the study area was gauged by carrying out the laboratory tests against the various standards of water purported by the Bureau of Indian Standards (BIS). Groundwater samples as well as surface water samples from ponds and canal were analyzed for alkalinity, total hardness, chloride, fluoride, arsenic, nitrate concentrations, pH and Total Dissolved Solids (TDS). Results of the laboratory analysis are shown in Tables 2,3,4 and 5. It can be seen in tables 2 to 5 that overall quality of ground water is satisfactory in Tehsil Koil and its blocks while the overall quality of ponds in Tehsil Koil and its blocks is poor.

Table 2: Qualitative study of water of existing resources Aligarh City

Water resources	Alkalinity mg/L	Total hardness mg/L	Chloride ions mg/L	pH value	Total dissolved solids mg/L	Quality of water
Ground water 18m depth	320	181	115	7.05	630	Good
Ground water 30 m depth	335	205	150	7.03	560	Good
Ground water 90m depth	360	300	355	7.08	520	Good
Pond 1	46	61	31	8.9	870	Poor
Pond 2	33	51	35	8.7	933	Poor
Pond 3	38	57	40	8.3	853	Poor
Pond 4	44	56	29	8.4	865	Poor
Pond 5	40	54	27	8.2	859	poor

Table 3:Qualitative study of water of existing resources Jawan block

Water Resources	Alkalinity mg/L	Total hardness mg/L	Chloride ions mg/L	pH value	Total dissolved solids mg/L	Quality of water
Canal water	76	50	15	7.52	160	Poor
Ground Water 18m depth	160	95	7.09	6.93	173.20	Good
Ground Water 30m depth	450	236	215	7.17	10.85	Good
Pond1	38	59	34	7.98	1102	Poor
Pond 2	40	63	37	7.8	1209	Poor

Table 4: Qualitative study of water of existing resources Lodha block

Water Resources	Alkalinity mg/L	Total hardness mg/L	Chloride ions mg/L	pH value	Total dissolved solids mg/L	Quality of water
Canal water	75	49	16	7.62	165	Poor
Ground Water 18m depth	201.7	142	79.9	7.41	372.5	Good
Ground Water 30m depth	230	190.3	80.7	6.98	455	Good
Pond	44	55	43	8.8	756	Poor

Fluoride, arsenic and nitrate tests were conducted on groundwater samples collected .Although, according to the methodology adopted for determining the groundwater reserves in the present study (*i.e*., the groundwater reserves for villages has been computed on the basis of groundwater availability per unit area of the entire Aligarh istrict multiplied by the individual village areas), the total existing water resources of the joining villages are scarce and are replenished from the groundwater reserve of Tehsil Koil.

Table: 5: Qualitative study of water of existing resources of Dhanipur Block

Water Resources	Alkalinity mg/L	Total hardness mg/L	Chloride ions mg/L	pH value	Total dissolved solids mg/L	Quality of water
Ground water 18m depth	280	65	144	7.01	555	Good
Ground water 30m depth	355	74	160	7.2	470	Good
Pond 1	44	55	28	8.4	888	Poor
Pond 2	35	39	44	7.93	1120	Poor
Pond 3	41	46	39	8.6	890	Poor

9. RESULTS AND DISCUSSION

A comparison between gross existing water resources of the study area and the total water requirements for irrigation as well as domestic purposes has been carried out and summarized in Table 2.it can be seen in Table 2. that the water availability in water resources of Tehsil Koil and its Blocks, except in Lodha Block where the availability is marginally greater than the water requirement, is lesser than the water requirement. Though the situation at present is not very critical, however, it may become critical in near future as the growth rate in population is increasing and life styles of people are changing day by day.

The quality of water within the study area is safe and acceptable for domestic and irrigation requirements except for the pond waters in Aligarh city and their adjoining four blocks having alkalinity, chloride, total hardness and TDS at levels of maximum permissible limits in accordance to Bureau of Indian Standards (BIS).

10. CONCLUSIONS

The present study has been carried out to evaluate the potential of existing water resources of Tehsil Koil and their four adjoining blocks in light of the increasing population density within the study area and the following conclusions are being made.

Water resources in Tehsil Koil and their four adjoining blocks, except Lodha Block, are sufficient to fulfill the needs of the people of the region but due to rapid growth in population and changes in the lifestyle of the people, certain strategies like Rain water harvesting, Ground water recharging, Water use education, Efficient irrigation methods, should be adopted for sustainable water management and development of Tehsil Koil. Use of submersible pumps should be monitored and controlled for proper water withdrawal to preserve the ground water table level. Ponds are proposed to be constructed in which water can be stored during rainy season and can serve cattles for drinking. During monsoon season plenty of water through rain is available which often stands in localities for longer duration causing miseries to the people and health hazard, if this water is detained in ponds, it would not cause flooding of the localities and can simultaneously be used for fisheries which in turn would provide job benefits and business to the people of the village which in turn leads to a sustainable development of the region.

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